number of thirty-seven and a half millions should be contained in about two drachms of water, as quoted by Tyndall, from Mr. Dancer's examination,[*] it is probable that the whole or repeated units of such millions might be harmlessly swallowed. But for the most part the supposed germs were not germs of any kind, but broken scraps of vegetable and animal tissues, spiral vessels from dried horse-dung, hairs, wings, and legs of insects, detrita of dress, and the like. The results were, in fact, entirely negative of any peculiar bodies to which the epidemic disease could be referred. One general result arrived at at that time, however, agrees with the observation of Tyndall in his recent investigation of dust by a beam of light—viz., that the floating particles in the air are chiefly of an organic nature. This we might have been prepared for, from the specific weight of dried organic material, enabling such dust to float, when the heavier inorganic substances would be deposited. That the infectious diseases spread by emanations from the sick, must have been long known, and that such emanations are of a solid nature, we may infer from the fact that they may be dried and conveyed from place to place; but in what state, whether as amorphous material or as germs, we know no more to-day than was known a thousand years past. No new fact bearing upon the propagation of contagious disease has been reached by the recent investigations on dust; nor can we infer the nature of summer catarrh because the nasal mucus under such circumstances and at no other time, was found peopled by vibriones, since decomposing mucus is always populous with this common race of infusoria. The phenomena of fermentation and putrefaction in dead and decomposing substances afford no explanation of the changes observed in a living body in a fever process. The purulent matter produced in small-pox, is not, as we know, in any way comparable to the yeast formed in fermenting fluids. On the contrary, the microscope demonstrates that the forms, as for instance in variolous pus, are not different from those contained in other purulent and innocuous exudations. Nor have we any reason to conclude that any forms which are observed are germs which convey the disease. It is to be regretted that a confusion in terms has been made. Instead of dust and disease it ought rather to have been dust and putrefaction, or dust and fermentation, since the relation of dust to disease has not been revealed anywhere in the inquiry. That the air conveys the material causes of the infectious diseases from the sick to the healthy, is a notorious fact, which had equal force before these inquiries were instituted, though, owing to the exigencies of social intercourse, a fact more neglected than in times of comparative ignorance. It is difficult to vindicate exactness in progress without seeming to be at the same time a hinderer of it. The onward and the regulating forces of a machine, though not incompatible, but necessary, require the nicest balance. This reflection suggests itself by the way the spread of infectious diseases has been handled. The theories it has given rise to have been so easily put forward as to thereby create distrust. But the spirit of science is no favourer of negations. 'Der Geist der stets verneint' finds no greater friend in medicine than in theology. Still it will be admitted that no progress can be made by the ready acceptance of every proposition, however distinguished the source from which it emanates. The parasitic origin and nature of epidemics *may* be true, but it has yet to be proved. As an hypothesis, it admits of proof or disproof, and so has further claim upon the industry of those who have put it forward as a suggestion. Without going to the length which this hypothesis demands, we must admit, however, that we know enough to guide us much further than we have yet gone in the practice of prevention."

PROFESSOR TYNDALL'S LECTURES AT THE ROYAL INSTITUTION, ON ELECTRICAL PHENOMENA AND THEORIES

PROF. Tyndall completed a short course of seven lectures at the Royal Institution, on Thursday, June 9th, upon "Electrical Phenomena and Theories," which were made as interesting as all his lectures are, by the ingenuity and completeness of the experimental illustrations; in this particular case the apparatus of his distinguished predecessor, Faraday, being largely drawn up, in addition to considerable accessions of more recent date, many of them derived from the kind help of individuals who have made themselves high reputations in the various branches of Electrical Science. The scope of the Professor's demonstrations covered the entire range of Electrical and Magnetic Science, commencing with the phenomena of voltaic electricity, and passing through the various leading manifestations and peculiarities of electro-magnetism, magnetic force, frictional electricity, electro-chemistry, magneto-electricity, and, of course, electric telegraphy, and the relations of electric motive force to heat.

One remarkable peculiarity in these lectures of Professor Tyndall is, the effective way in which several of the more subtle effects of electrical change and power are made manifest to a large audience by the instrumentality of beams of electric light, manipulated in various ways. Thus, for instance, the elongation of a solid bar of iron, when it is thrown into the magnetic state, by being encircled in the folds of a voltaic current, conveyed by a helix, is shown by the starting of a spot of light, some six or eight inches upon a screen, when the molecular condition of magnetism is excited by the passage of the current. A beam of light falls upon a small mirror, carried at the extremities of the arm of a lever, so resting upon the end of the iron bar, that when the lever is lifted by the magnetic elongation of the bar, the beam of light is shot off from the mirror as a long weightless index. The change in the position of the molecules of iron by the action of magnetism is also proved by throwing the beam through a vertical cell of glass, containing magnetic oxide of iron suspended in water. When the cell is exposed to the influence of the poles of a strong electro-magnetic, the light passing through the cell and contained liquid to a screen beyond, brightens, in consequence of the metallic molecules turning themselves "end on" to the incidence of the beam. The lines of magnetic force assumed, when iron filings are sprinkled over the poles of a magnet, are portrayed by the intervention of a system of lenses, which depicts the image upon the screen. The formation of the "tree of lead" upon the negative electrode of a voltaic current, when a salt of lead is decomposed by the current, is shown in the same way; the arborescent crystals glowing and dissolving alternately on the opposite poles, immersed in the solution as the direction of the current is reversed. The very beautiful colours and patterns of Nohili's rings, formed when lead is thrown down by voltaic decomposition upon a polished plate of steel, are exhibited by a similar intervention of lenses, and the illumination from the electric beam. An artificial telegraph cable, whose resistance to the transmission of the electric current is made identical with 14,000 miles of an actual marine cable, is formed by introducing into the path of the current gaps, consisting of feebly conducting liquids and condensers, so distributed as to represent the respective distances by telegraphic route of Gibraltar, Malta, Suez, Aden, Bombay, Calcutta, Rangoon, Singapore, Java, and Australia. A mirror, belonging to each gap, lies in the path of the currents, carried by a galvanometer, constrained to deflect its needle from the position of both on the instant that the passage of the current is felt. Before the current is sent through the apparatus, ten dots of light, cast from the mirrors by the instrumentality of electric illumination, lie upon the screen, in a straight vertical range. When the current is passed through the apparatus, dot after dot starts aside upon the screen, as the current fills the condenser immediately before each mirror, and then flows beyond to deflect the galvanometer immediately in advance. The deflection of the successive galvanometers, and the corresponding traverse of the beam of light upon the screen, is seen, under this arrangement, to take place at successive steps or intervals, which exactly express the intervals of time which the electric current would require to reach the several stations named, in the actual progress of telegraphy. The starting aside of spot after spot upon the screen when the current is sent through the apparatus, and the subsequent return of spot after spot to the position of original test in inverse order, forms a very striking illustration of the fact that the resistance of an electric cable is in some degree dependent upon its length, and that time is consumed in overcoming this resistance. The most interesting and telling of all these beam-of-light illustrations, however, is certainly the one which is employed to indicate the excitement of diamagnetic force in a tube of copper, when it is suspended between the poles of an electro-magnetic. The tube is carried by a string of silk, and rotates rapidly under the influence of a twist given to the string. The string also carries above the tube a series of small mirrors, which reflect the light of an electric beam, so that a continuous elliptical band of illumination is formed on the screen whilst the twisting is con-

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[*] Proceedings of the Royal Institution of Great Britain, Jan. 21, 1870.

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tinued. The instant the electro-magnet is made active by the transmission of the current through its helix, the copper tube acquires diamagnetic polarity by induction, and under the influence of this polarity the rotation is arrested, and the band of lights upon the screen is changed into a small stationary spot of illumination. When the electro-magnet is unmade by the arrest of the voltaic current, the spot of light again becomes an elliptical band, under the resumption of the twisting of the silk string with its mirrors and copper tube.

Of the numerous other very pleasing and telling illustrations exhibited in these lectures, space only permits allusion to be made to a very few which have been selected from the series, as being worthy of especial mention. The sound produced by the molecular vibration in iron when its mass is transiently magnetised by the voltaic current, is made audible by suspending an iron poker upon two sounding boards, and making it the core of a helix, conveying an electric current. An assistant is converted into an extemporised electrophorus, by flapping his black coat with fur while he stands upon a glass-legged stool. Small fish of gold leaf are made to float in the air current given off from the knob of a charged Leyden jar. A thick drinking glass is shattered by the expansion of the water contained in it, when sparks formed under the intensifying power of fifty condensers joined "in cascade," and primarily charged by a voltaic battery of one thousand cells, are passed through the liquid. To demonstrate the relation of resistance to heating power, a long line of wire is arranged in alternate links of platinum and silver, and when a voltaic current of due intensity is passed through the length, each stretch of the platinum wire is seen to glow with brilliant red heat, while the stretches of silver wire between remain still invisible. A beautiful series of Geissler's vacuum tubes were brought into successive operation, in which the auroral discharge was broken into stratified leaves, in which the glow was extinguished by the approximation of the poles of an electro-magnet, in which a feeble glow was converted into bright stratified light by the influence of a magnet; and beautiful beyond all the rest, the light from the enclosed negative terminal of the voltaic battery was arranged into the well-known lines of magnetic force, when subjected to the influence of the poles of a magnet.

It would be unnecessary in alluding to these very admirable lectures, to say one word of Prof. Tyndall's clearness and power as an expositor of the phenomena of Physical Science. These are now well known to the hundreds who are attracted to Albemarle Street on the frequently renewed occasions when the Professor performs this portion of his functions as a lecturer of the Royal Institution. It is, however, well worth while to draw attention to a device which the Professor adopts, with the happiest effect, to render his lectures as complete in their instruction as they can be made. He prints a series of well-digested "Notes" of the entire range of the subjects he passes over in each lecture, has them placed in the hands of each individual as he enters the lecture room, and then refers from time to time to the systematic outline, as occasion suggests the expediency of doing so. By this procedure the Professor is able to give full attention and time to each step of his illustrative demonstration, without being hampered with the need of telling everything that he has marked out beforehand—an extremely difficult thing to accomplish in a brief unextensible interval, where *viva voce* teaching has to be employed. Under this management any broken or omitted link in the full argument is readily recovered by glancing the eye over the range of printed notes after the conclusion of the lecture. This plan is well worthy of adoption, wherever popular lectures upon science are delivered to large audiences, with a view to instruction as well as amusement.

ZOOLOGY

Plateau on the Flight of Coleoptera

M. FELIX PLATEAU has supplemented the recent labours of Marey and others upon the flight of insects by examining the movements of the wings of certain Coleoptera. Specimens of the common May-beetle and *Oryctes nasicornis* were selected for experiment. The apparatus used consisted of two pulleys, fastened one above the other, at a distance of two centimetres, on a vertical support; the upper pulley made twelve turns for each one made by the lower, and could be caused to rotate twenty-four times in a second. The insects were killed by ether vapour immediately before each experiment; and the wings could be fastened, by a simple contrivance, to the front prolongation of the axis of the upper pulley.

A wing, in its folded state, was fixed on the instrument in such a manner that its plane made, with the plane of rotation, an angle of 45°, as in the living animal. On turning the pulleys, it struck the air obliquely by its upper surface and front margin; but the small diameter of the apparently continuous revolving disc (as indicated by a graduated scale) proved that the wing was still folded, and that centrifugal force had not affected it. When rotation was produced in an opposite direction, so that the wing struck the air both by its posterior membranous margin and inferior surface, the increasing diameter of the disc gave proof of the expansion of the wing, which, indeed, continued to be much extended when motion was arrested. When the plane of a wing was perpendicular to the plane of rotation, and the revolution of the wheel was such that the wing struck the air by its dorsal or upper surface, no extension ensued; when it struck by its lower surface, only partial extension followed. Now the oblique, not the perpendicular plane is that chosen by nature, and is, as has been seen, much more favourable for flight.

On fixing an open wing on the axis so as to make an angle with the plane of rotation, and turning in one direction, the wing remained open; on reversing the direction (*i.e.* acting on the upper surface) it became partially closed.

SCIENTIFIC SERIALS

IN the *Revue des Cours Scientifiques* for July 9, we have an important article on the Axioms of Geometry, by Prof. Helmholtz, which has, however, already appeared in an English form in the *Academy*, and the translation of an article by Mr. E. J. Reed, on *Navires blindés*; while M. Bernard concludes his course on Suffocation by the Fumes of Charcoal. In the number for July 16 there is an address by M. Dumas, delivered before the Academy of Sciences in honour of M. Pelouze, which occupies nearly the whole of the number, leaving room for only a short abstract of M. Bienaymés paper read before the Academy, on the military mortality in the Italian campaign of 1859-60.

Annales de Chimie et de Physique, May, 1870.—"Researches on the Gaseous Products of the Combustion of Coal," by M. A. Scheurer-Kestner. This important paper commences with an historical notice of experiments on this subject by Péclet, Ebelmen, Debette, Commines de Marsilly, Ebelmen and Sauvage, Foucou and Amiguis, and Cailleet, pointing out several causes of inaccuracy which are to be traced in their researches. The author then describes the process employed by him in collecting and analysing the gases from the flue of a steam boiler. Through the brickwork of the furnace a hole was bored, and in it was placed a platinum tube about 700 millimetres long and ten in diameter. To one end of this tube a copper pipe surrounded by a Liebig's condenser is soldered, the other end being closed with a plug. A narrow slit extends the whole length of the platinum tube, so that the air drawn through it is an average specimen of the gas in the flue. It is found also that the gas must be slowly aspirated through the slit in order to obtain a fair average of the gas passing through the flue during a considerable space of time. The author connected the apparatus with a water aspirator, by which he drew $\frac{1}{1000}$ of the total gas which passed up the chimney through the platinum tube; at the same time, from $\frac{1}{250}$ to $\frac{1}{500}$ of the aspirated gas was removed by a branch and collected in a bottle of three litres capacity, from which mercury was allowed to flow very slowly. Thus about $\frac{1}{500000}$ of the gas in the chimney was collected over mercury, and with this the analyses were performed. For the analytical processes we must refer the reader to the original paper, merely pointing out the conclusions at which the author has arrived. The gases of the chimneys were almost always found to contain carbonic oxide and hydrocarbons, even in the presence of oxygen arising from excess of atmospheric air. It was also found that the quantity of carbon lost in the form of smoke in the presence of sufficient air was about $\frac{1}{2}$ per cent., and that the loss of carbon as combustible gases does not exceed 2 or 3 per cent. when the excess of air amounts to 30 per cent. or more. The paper concludes with a section on the theory of the formation of smoke in the presence of an insufficient quantity of air, in which the author discusses the observations of Sainte-Claire Deville on dissociation, and of Berthelot on the action of heat on hydrocarbons, and points out their application to this subject.

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